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ADEQUACY OF THE WATER FLUORIDATION CONTROL PROGRAM IN SOUTH DAKOTA

AN EVALUATION OF WATER FLUORIDATION AT SELECTED WATER SUPPLY SYSTEMS IN THE STATE OF SOUTH DAKOTA

ENVIRONMENTAL PROTECTION AGENCY, DENVER, COLORADO

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An Evaluation of Water Fluoridation
At Selected Water Supply Systems
In the State of South Dakota

Thomas N. Hushower, P.E.
Chief, Special Studies Section
Office of Water Program Operations
Environmental Protection Agency

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16. Abstracts Sixty-four public water supply systems in South Dakota were fluoridating in September 1973, serving an estimated population of 327,000. Twenty-seven communities, population 15,000 were using water sources containing natural fluorides within the recommended range. Of the 276 reported public water supplies in the state, 91 (33 percent) were fluoridating or using one or more water sources containing natural fluorides within the recommended range. Recommendations are offered regarding: promotion of fluoridation of all public water supplies in the state; maintaining fluoride ion content within recommended limits; enforcement of state fluoride standards; requirements for fluoride ion analyses; development of specific regulations for the installation of fluoridation equipment; promulgation of regulations for storage and handling fluoride chemical compounds and of training in safe handling practices.

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ADEQUACY OF THE WATER FLUORIDATION CONTROL PROGRAM IN SOUTH DAKOTA

Introduction

On March 25, 1969, the State of South Dakota enacted legislation requiring the fluoridation of all municipal water supplies serving populations of 500 or more. 1/ In September 1973, sixty-four communities with a total population of 327,900 (1970 Census) were fluoridating. Table I, Fluoridated Water Supply Systems in South Dakota, tabulates the water systems reported fluoridating and the date fluoridation was started. Recognizing the importance of controlling the fluoride ion content in the water distribution system to within the recommended range for optimum dental benefits, the South Dakota Department of Health requested the Water Supply Division of the Environmental Protection Agency (EPA) to evaluate the adequacy of the State program responsible for surveillance of the fluoridated water supplies in South Dakota. 2/ This Report on the "Adequacy of the Water Fluoridation Control Program in South Dakota" has been prepared in response to the request.

The recently established State Department of Environmental Protection, Office of Air and Water Quality, Water Hygiene Program, is responsible for approval and surveillance of the operations of all public water supplies in South Dakota including all fluoridation installations. This

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1/ A copy of the South Dakota Fluoridation Law approved March 25, 1969, is included in the Appendix.

2/ A copy of the letter from the South Dakota Department of Health to the Environmental Protection Agency requesting the evaluation is included in the Appendix.

SOUTH DAKOTA FLUORIDATION PROGRAM EVALUATION
Table 1
Fluoridated Water Supply Systems In South Dakota

Water Supply System	Location (County)	Date Fluoridation Started	1970 Census Population
Aberdeen	Brown	2/51	26,476
Belle Fourche	Butte	1/71	4,236
Beresford	Union	7/71	1,655
Bowdle	Edmunds	7/72	667
Box Elder	Pennington	4/73	607
Brandon Water Co.	Minnehaha	1/71	1,431
Bridgewater	McCook	10/72	633
Britton	Marshall	6/71	1,465
Brookings	Brookings	12/61	13,717
Burke	Gregory	5/72	892
Canistota	McCook	10/72	636
Castlewood	Hamlin	4/73	523
Centerville	Turner	7/73	910
Chamberlain	Brule	7/71	2,626
Clark	Clark	11/71	1,356
Clear Lake	Deuel	11/71	1,157
Custer	Custer	8/71	1,597
Dell Rapids	Minnehaha	8/71	1,991
DeSmet	Kingsbury	10/71	1,336
Estelline	Hamlin	10/72	624
Faith	Meade	6/72	570
Flandreau	Moody	9/71	2,027
Fort Pierre	Stanley	3/72	1,448
Freeman	Hutchinson	1/72	1,357
Gregory	Gregory	7/69	1,756
Hartford	Minnehaha	1/73	800
Highmore	Hyde	1/72	1,173
Hosmer	Edmunds	4/57	437
Hot Springs	Fall River	10/70	4,434
Howen	Potter	7/72	671
Huron	Beadle	9/56	14,299
McCook Lake	Union	10/72	500
Lake Andes	Charles Mix	1/72	948

Water Supply System	Location (County)	Date Fluoridation Started	1970 Census Population
Lead - Deadwood	Lawrence	10/70	5,420 2,409
Madison	Lake	5/70	6,315
Martin	Bennette	11/71	1,248
McLaughlin	Corson	10/72	863
Milbank	Grant	4/68	3,727
Mitchell	Davidson	11/54	13,425
Mobridge	Walworth	3/52	4,565
Murdo	Jones	9/72	865
Parker	Turner	1/69	1,005
Parkston	Hutchinson	1/72	1,611
Philip	Haakon	5/72	983
Pierre	Hughes	8/68	9,699
Rapid City	Pennington	8/70	43,836
Rapid Valley Water Service Company	Pennington	7/71	1,800
Salem	McCook	3/71	1,301
Scotland	Bon Homme	6/72	904
Selby	Walworth	5/72	957
Sioux Falls	Minnehaha	10/70	72,488
Sisseton	Roberts	4/72	3,094
Spearfish	Lawrence	11/70	6,841
Springfield	Bon Homme	6/67	1,566
Sturgis	Meade	12/70	4,596
Vermillion	Clay	10/51	9,128
Volga	Brookings	4/72	984
Wagner	Charles Mix	7/71	1,655
Watertown	Codington	9/53	13,388
Webster	Day	1/70	2,252
Wessington Springs	Jerauld	5/66	1,300
Winner	Tripp	8/70	3,703
Woonsocket	Sanborn	5/72	650
Yankton	Yankton	11/70	11,919

responsibility was transferred from the State Department of Health when the Department of Environmental Protection was created. Regulations for the fluoridation of municipal water supplies in the State are prescribed in the SDCL Chapter 34-24A, and State Health Department Regulation 2.17. (Copies of these regulations are included in the Appendix.) The State recommended fluoride ion range in municipal water supplies is 0.9 - 1.7 mg/l with an optimum level of 1.2 mg/l fluoride; however, the Water Hygiene Program policy is to require municipal water supplies fluoridating to control the fluoride ion content to within a range of 1.0 - 1.4 mg/l.

In addition to the sixty-four fluoridated community water supply systems in the State, twenty-seven communities, population 15,000, were using water sources containing natural fluorides within the recommended range (0.9 - 1.7 mg/l); and twenty-one communities, population 9,600, were using water sources containing natural fluorides within a range of 1.8 - 2.4 mg/l. Sixty communities, population 24,500, were supplying water with natural fluorides greater than 2.4 mg/l or two times the recommended optimum level. (A tabulation of community water supplies in South Dakota containing natural fluorides of 0.9 mg/l or higher and a map locating the communities with natural fluoride levels > 2.4 mg/l are included in the Appendix.) There were 276 reported public water supplies in the State January 1971, not including two rural water districts and federal, state, Indian and housing subdivision water supplies. 3/ Ninety-one communities serving a population of 343,000 (1970 Census) or 33 percent

3/ South Dakota Public Water Supply Data, January 1971, Division of Sanitary Engineering and Environmental Protection, South Dakota State Department of Health.

of the public water supplies in the State were, therefore, supplying or attempting to supply water containing fluorides within the recommended limits. South Dakota, one of nine States with a mandatory fluoridation law, ranks 7th of all States in percentage of population of public water supplies with natural or controlled fluoridation.

The proven benefits in dollars derived from fluoridation to prevent dental caries for the population in South Dakota presently served by fluoridated water are estimated to be $3.0 million annually.4/ The annual cost to the sixty-four communities to fluoridate their water is estimated at $52,500 and the annual cost to the State for implementing a satisfactory fluoridation program is estimated at $50,000 giving a benefit cost ratio to the State of 29 to 1. To receive full value of the benefits of fluoridation, it is essential that the fluoride ion level in the water supplies of the communities presently fluoridating be maintained as close to the optimum value (1.2 mg/l) as possible since a reduction of as little as 0.2 mg/l below the optimum can reduce the benefits of fluoridation by 50 percent.

Evaluation Procedure

To evaluate the adequacy of the South Dakota Department of Environmental Protection's water fluoridation control program, eighteen fluoridated water supply systems were selected for survey. The choice of eighteen systems representative of the sixty-four fluoridation installations in South Dakota was based on geographical location, population served, source

4/ Calculations of the Fluoridation Benefits in South Dakota are included in the Appendix.

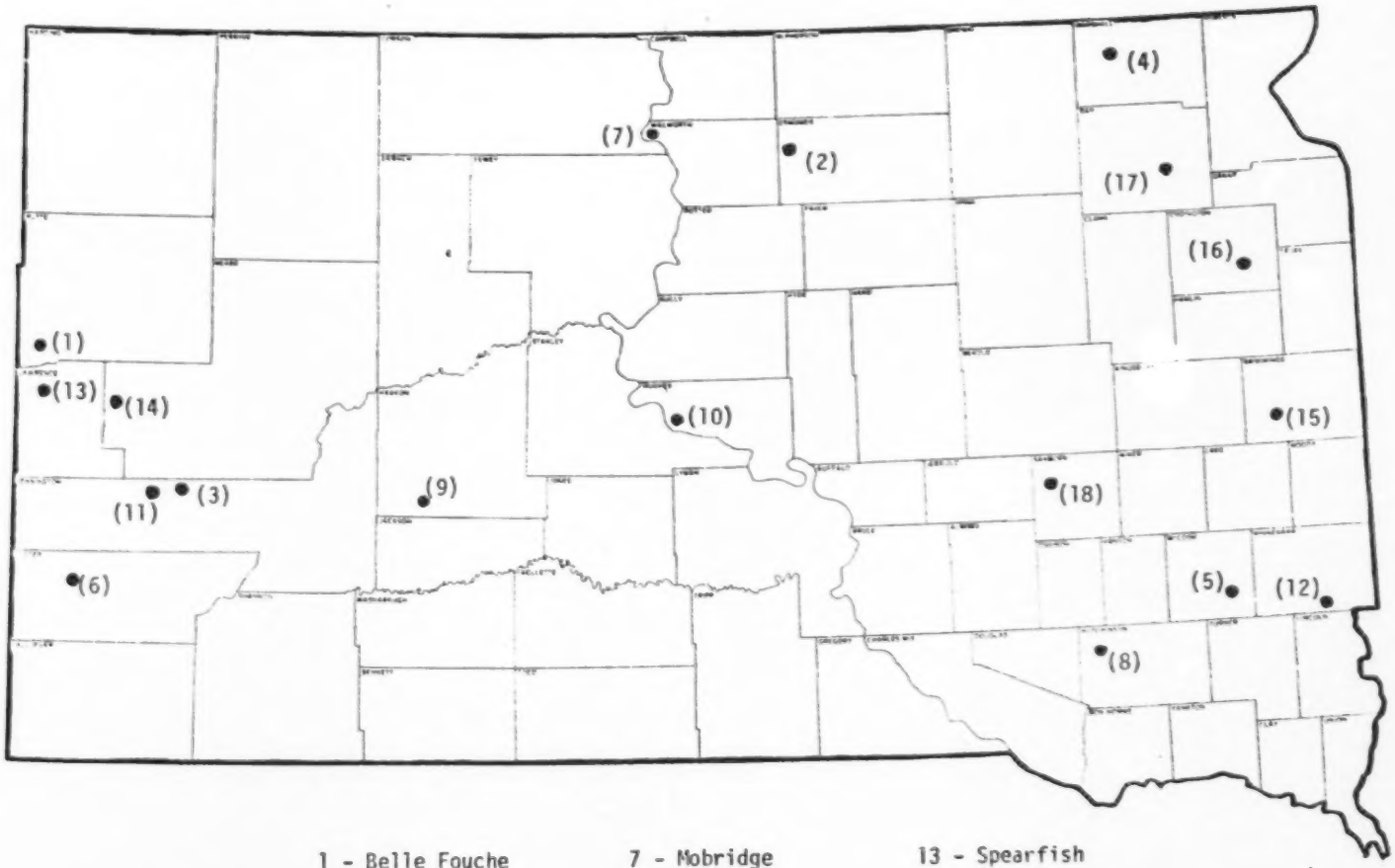
of water supply (ground or surface water), and fluoride compound used in fluoridation. Figure 1, Fluoridated Water Supply Systems Selected For Study, locates the eighteen installations and Table II summarizes pertinent information on each facility.

The survey of the eighteen representative fluoridation installations included a review of the state fluoridation records for the supply, a field inspection visit to the facility, completion of a survey form,[5/] and collection of water samples for fluoride ion analysis. Each installation was examined with respect to: fluoride ion content in the distribution system; analytical control of the fluoride ion level (records kept); fluoride chemical feed equipment and facilities; fluoride chemical compound storage and handling; operator training and interest; and, surveillance.

The actual level of fluoride ion in the distribution system is the single most important factor in evaluating the adequacy of a community water fluoridation effort and hence in evaluating the State program responsible for approval and surveillance of the installation. However, as distribution samples collected on one particular day may not give a true picture of day-to-day operating conditions, the installations were also evaluated with respect to the following:

5/ A copy of the questionnaire used in the South Dakota Fluoridation Survey is included in the Appendix.

SOUTH DAKOTA FLUORIDATION PROGRAM EVALUATION
Figure 1
Fluoridated Water Supply Systems Selected for Study



1 - Belle Fouche
2 - Bowdle
3 - Box Elder
4 - Britton
5 - Canistota
6 - Custer
7 - Mobridge
8 - Parkston
9 - Philip
10 - Pierre
11 - Rapid City
12 - Sioux Falls
13 - Spearfish
14 - Sturgis
15 - Volga
16 - Watertown
17 - Webster
18 - Woonsocket

SOUTH DAKOTA FLUORIDATION PROGRAM EVALUATION
TABLE II
FLUORIDATED WATER SUPPLY SYSTEMS SELECTED FOR STUDY

Water Supply System	Population Served	Source of Supply	Avg. Use (MGD) 1/	Fluoride Compound	Type of Feeder	Analysis Method	Test Equipment
Belle Fourche	4,500	Infiltration Gallery	0.5 W 2.5 S	VT	PS-1	S	T-1
Bowdle *	700	5 - Wells	0.05 W 0.17 S			S	T-1
Well #1				VT	PS-2		
2				VT	PS-2		
3 & 4				VT	PS-2		
6				VT	PS-2		
Box Elder	1,700	2 - Wells	0.06 W 0.08 S			S	T-1
Well #1				VT	PS-3		
2				VT	PS-3		
Britton	1,450	White Lake	0.16 W 0.28 S	VA	P-1	S	T-1
Canistota *	600	2 - Wells	0.05 W 0.06 S	VT	PS-2	S	T-1
Custer	1,800	3 - Wells	0.15 W 0.25 S			S	T-1
Well #2				VT	PS-3		
4				VT	PS-3		
5				VT	PS-3		
Mobridge	4,900	Oahe Reservoir	0.30 W 1.50 S	VT	V-1	S	T-1
Parkston *	1,600	2 - Wells	0.18 W 0.30 S	VT	PS-4	S	T-1
Philip *	1,400	Lake Waggoner & Artesian Well	0.12 W 0.30 S	VT	PS-5	S	T-1
Pierre	9,800	8 - Wells	1.70			S	T-1
Well #1				VA	P-1		
2				VA	P-1		
3				VA	P-1		
4				VA	P-1		
5				VA	P-1		
6				VA	P-1		
7				VA	P-1		
8				VA	P-1		
Rapid City *	49,000	Rapid Cr., 2-Infiltration Galleries, Jackson Spr.	7.30			S	T-1
Rapid Creek				VS	V-2		
Girl Scout				VS	V-3		
Meadowbrook				VS	V-3		
Jackson Spring				VS	V-3		
Sioux Falls *	80,000	30 - Wells & Sioux R.	11.0 W 18.0 S	VS	G-1	S**	T-1
Spearfish	6,400	Spearfish Cr., Spearfish Spr., 1 - Well	1.1 W 2.4 S			S	T-1
Spearfish Canyon Cr.				VT	PS-1		
Spearfish Park Spr.				VT	PS-1		
Dickey Well				VT	PS-1		
Sturgis	5,600	3 - Wells, Warren Cr.	0.40 W 0.98 S			S	T-1
Well #1 & 3				VT	PS-5		
Warren Creek				VT	PS-1		
Well #2				VT	PS-5		
Volga *	1,000	5 - Wells	0.20			S	T-1
Well #2				VT	PS-6		
3				VT	PS-7		
4				VT	PS-6		
5				VT	PS-2		
6				VT	PS-2		
Watertown	14,600	8 - Wells, Lake Kampeska	2.0			S	T-1
Plant #1 (5 wells)				VS	V-2		
Kampeska				VS	V-3		
Well #4				VT	PS-2		
5				VT	PS-2		
8				VT	PS-4		
Webster *	2,200	5 - Wells	0.16 W 0.35 S	VT	PS-5	S	T-1
Woonsocket *	800	2 - Wells	0.04 W 0.07 S			S	T-1
Well #1				VT	PS-2		
2 2/							

Fluoride Compound
VA - Fluosilicic Acid
VS - Sodium Silicofluoride
VT - Sodium Fluoride

Analysis Method
S - Spadns

Type of Feeder
G-1 Gravimetric - BIF 31-12 Loss-in-Weight
P-1 Diaphram Pump - W & T A-747
V-1 Volumetric - BIF 50-A Rotating Disk
V-2 Volumetric - W & T A-690 Screw Type
V-3 Volumetric - W & T A-378 Roll Type
PS-1 Diaphram Pump - W & T A-747, Saturator
PS-2 Diaphram Pump - W & T 94-100, Saturator
PS-3 Diaphram Pump - W & T A-748, Saturator
PS-4 Diaphram Pump - W & T A-416, Saturator
PS-5 Diaphram Pump - W & T A-745, Saturator
PS-6 Diaphram Pump - F & P 71 R 2000, Saturator
PS-7 Diaphram Pump - PCF Models, Saturator

Test Equipment
T-1 Photometer - Hach DR
T-2 Spectrophotometer - B & L Spectronic 20
T-3 Spectrophotometer - Hach DR/2

* Representative Attended Fluoride Determinations in Water Training Course, Huron, S.C., Nov. 28-30, 1972.

1/ W-Winter; S-Summer
2/ Supply Not Fluoridated

I. Analytical Control of the Fluoride Ion Level

A. Were the fluoride ion analyses conducted at the water plant accurate within ± 0.1 mg/l of the value determined by the Environmental Protection Agency?

B. Were finished water samples analyzed daily or more frequently for fluoride ion content?

C. Were raw water samples analyzed regularly for fluoride ion content?

D. Were laboratory equipment and facilities at the water plant adequate to conduct fluoride ion analysis according to one of the three standard methods?

E. Was laboratory equipment clean and given responsible care?

F. Were complete records kept of the fluoride operation?

II. Fluoride Chemical Feed Equipment and Facilities

A. Were the fluoride feed equipment and facilities adequate to control the fluoride ion level in the finished water?

B. Was positive protection provided against overfeeding? Was backflow protection provided? Was equipment location and point of fluoride chemical application at the best practical site? Was the feed equipment site uncluttered?

C. Was the fluoride chemical feed installation operated continuously for the past twelve months without an interruption of more than one day?

D. Were the fluoride chemical feed equipment and facilities maintained satisfactorily?

III. Fluoride Chemical Compound - Storage and Handling

A. Was the fluoride chemical compound stored in a safe, protected and orderly manner?

B. Was safety equipment available and were safe procedures followed in handling the fluoride chemical compound?

C. Were fluoride chemical shipping containers disposed of satisfactorily or re-used only for fluoride chemical storage?

IV. Operator Training and Interest

A. Were plant operating personnel well-trained to operate the fluoride chemical feed equipment and facilities?

B. Were personnel conducting the fluoride ion analyses knowledgeable of their test equipment and standard procedures for analysis?

C. Was the water plant official interviewed in favor of fluoridation and was he interested in adding fluorides to public water supply systems?

V. Surveillance

A. Were check samples for fluoride ion analysis submitted to the state as required?

B. Had the water fluoridation installation surveyed been inspected in the past twelve months by a representative of the state water supply program surveillance agency?

Summary of Findings

Data collected on the eighteen surveyed fluoridated water supply systems in the State of South Dakota indicated ten (56 percent) of the systems contained a fluoride ion content in the distribution system at the time of the survey within the 1.0 - 1.4 mg/l range required under the policy of the State Water Hygiene Program. Eight (44 percent) of the facilities were overfeeding, i.e. the fluoride ion levels in the samples collected from the distribution systems were greater than 1.4 mg/l. Table III, Analysis Of Samples From Selected Fluoridated Water Supply Systems, tabulates the fluoride ion analysis of the water samples collected at each facility surveyed. (Water distribution systems samples collected during the survey by the EPA were analyzed for fluoride ion content by the Electrode Method. Check samples, analyzed by the EPA and the South Dakota Laboratory, Table III, had a variation between 0.01 - 0.11 mg/l with an average difference of 0.05 mg/l. The State Laboratory used the Electrode Method for analysis and analytical procedures and technique followed were judged very acceptable. Duplicate samples were also analyzed with the Sioux Falls Health Department Laboratory, responsible for fluoride check sample analysis with the Sioux Falls Water Department--results were within 0.06 mg/l fluoride.)

A one year summary of the State Laboratory fluoride ion analysis check sample results for the installations surveyed is presented in Table IV, Summary Of Fluoride Check Sample Analysis Results. Of 534 fluoride samples received by the State from the installations surveyed, only 67 percent were within the 1.0 - 1.4 mg/l range while 20 percent were

SOUTH DAKOTA FLUORIDATION PROGRAM EVALUATION
TABLE III
ANALYSIS OF SAMPLES FROM SELECTED FLUORIDATED WATER SUPPLY SYSTEMS

Water Supply System	Date of Sample	Fluoride Content, mg/l (Date of Sample)				
		Raw Water	Operator	State	EPA	Distribution System
Belle Fourche	9/13	0.29	>2.0	2.38	2.30	1.76 2.90
Bowdle	10/15		1.4	1.46	1.39	1.45 1.50
Well #1						
2		0.34				
3 & 4						
6						
Box Elder	9/11		1.6	1.71	1.70	1.55 1.70
Well #1		0.49				
2		0.69				
Britton	10/16	0.24	1.3	1.45	1.43	1.47 1.50
Canistota	10/18	0.55	2.0	1.61	1.58	1.28 1.27
Custer	9/14		1.2		1.30	1.23 1.23
Well #2		*		1.20	1.23	
4		*				
5		*				
Mobridge	10/15	0.52	1.5	1.35	1.24	1.33 1.14
Parkston	10/18	0.58	1.62	1.19	1.28	1.28 1.28
Philip	9/14		1.7		2.20	1.49
Lake Waggoner		0.45		1.47	1.49	
Artesian Well		1.98				
Pierre	9/10		1.31		1.22	1.28 1.22
Well #1		*		1.38	1.37	1.22 1.37
2		*				
3		*				
4		*				
5		*				
6		*				
7		*				
8		*				
Rapid City	9/11		1.35	1.09	1.06	1.17 1.23
Rapid Creek		0.28				1.27
Girl Scout		0.32				
Meadowbrook		0.31				
Jackson Spring		0.27				
Sioux Falls	10/19	0.30	1.42	1.27	1.33	1.45 1.48
				1.3 **	1.36	1.45
Spearfish	9/12		1.6	1.46	1.40	1.40 1.44
Spearfish Canyon Cr.		0.31				
Spearfish Park Spr.		0.23				
Dickey Well		0.28				
Sturgis	9/13		1.17	1.20	1.14	1.24 1.14
Well #1		*				
3		0.29				
Warren Creek		*				
Well #2		0.22				
Volga	10/17		> 2.0	1.98	2.03	1.06 1.17
Well # 2		*				
3		*				
4		*				
5		*				
6		*				
Watertown	10/17		1.36	1.15	1.22	1.25 1.37
Plant #1 (5 wells)		0.22				
Kampeska		0.24				
Well #4		*				
5		*				
8		*				
Webster	10/16	0.46	1.26	1.08	1.17	1.22 1.17
Woonsocket	10/18		1.6	1.30	1.40	1.41 1.43
Well #1		0.75				
2		*				

* No Raw Water Sampling Point
** Sioux Falls Health Department Laboratory

SOUTH DAKOTA FLUORIDATION PROGRAM EVALUATION
TABLE IV
SUMMARY OF FLUORIDE CHECK SAMPLE ANALYSIS RESULTS 1/

Water Supply System	Check Samples 2/ Req'd/yr	Rec'd/yr	Fluoride Analysis Avg. (mg/l)	<1.0 mg/l (%)	1.0-1.4 mg/l (%)	>1.4 mg/l 3/ (%)
Belle Fourche	24	33	1.11	42	40	18
Bowdle 4/	12	12	1.21	17	75	8
Box Elder 5/	12					
Britton	12	23	1.08	35	61	4
Canistota	12	21	1.18	33	38	29
Custer 4/	12	33	1.17	21	61	18
Mobridge	24	20	1.13	10	90	0
Parkston	12	16	1.10	25	75	0
Philip 4/	12	19	1.47	5	32	63
Pierre	24	103	1.21	16	72	12
Rapid City 4/	52	51	1.16	12	80	8
Sioux Falls	52	52	1.18	4	94	2
Spearfish	24	22	0.98	45	46	9
Sturgis	24	26	1.07	27	69	4
Volga 4/	12	16	1.17	25	62	13
Watertown 3/	52	52	1.24	10	86	4
Webster	12	22	1.06	9	91	0
Woonsocket 4/	12	13	1.29	8	61	31
	Total	534	Avg.	20	67	13

1/ Per 1972 Laboratory Records, South Dakota Dept. of Environmental Protection
2/ Number of Check Samples Required:
Population >10,000 - 1 per week
Population 3,000 - 10,000 - 2 per month
Population <3,000 - 1 per month
3/ One Sample Exceeded 2.4 mg/l (2 x 1.2 mg/l Optimum)
4/ Year of Record Taken as Sept. '72 - Aug. '73.
5/ Fluoridation Started 4/73. Only 3 Months of Record Available.

less than 1.0 mg/l and 13 percent were greater than 1.4 mg/l fluoride. Four of the installations (Belle Fourche, Canistota, Philip and Spearfish) had less than 50 percent of their check sample results within the recommended range.

The operating conditions observed during the time of the survey of the eighteen fluoridation installations inspected are summarized as follows:

I. Analytical Control of the Fluoride Ion Level

Practices to analytically test and control the fluoride ion level in the distribution system varied at each installation. The SPADNS Method for fluoride ion analysis was used exclusively at each installation and portable photometers (Hach DR Test Kits) were employed at sixteen of the plants. No distillation procedures to remove possible interferences in the analysis were followed. Only seven (39 percent) of the plant operators or laboratory personnel testing water samples for fluoride ion content conducted the analysis within $\pm$ 0.1 mg/l of the duplicate samples analysis performed by the EPA.

Daily finished water fluoride ion analysis, required in the State Health Department Regulation 2.17, was conducted at only six (33 percent) of the installations and regular raw water fluoride ion analysis was conducted at five (28 percent). The raw water sources at three communities could not be sampled conveniently. Analytical equipment, laboratory facilities and care for analytical equipment were satisfactory at thirteen (72 percent) of the plants. Records of the fluoridation operation, specified by Regulation 2.17, were acceptable at only three (17 percent) of the installations surveyed.

II. Fluoride Chemical Feed Equipment and Facilities

Fluoride chemical feed equipment, facilities and feed arrangements were acceptable at nine (50 percent) of the plants visited. Automatic solution preparation equipment, down flow saturators, were used at thirteen of the water supplies visited; however, no sand layer was included in the tanks which is essential in the down flow saturator to prevent undissolved sodium fluoride from infiltrating into the solution feed reservoir. Another problem common with the saturator installations was the injection of the saturated fluoride solution into the water supply line at the same point calcium hypochlorite solutions were fed. This practice will cause a precipitate, plugging the injection lines.

Dry feeders and acid feed systems are not used extensively in the State. Of the sixty-four fluoridation installations in South Dakota, 73 percent were saturators, 16 percent dry feed, 8 percent acid feed and the remaining 3 percent were a combination of the three types. Since May 1972 new acid feed systems were not being approved by the State for safety reasons.

Twenty-three percent of the operators reported one or more interruptions in fluoridation of one or more days duration in the past twelve months. Half of these interruptions were attributed to mechanical problems with the feed equipment. In only one case was the lack of chemical the cause of the interruption. Maintenance was found satisfactory at fifteen (83 percent) of the facilities surveyed.

III. Fluoride Chemical Compound - Storage and Handling

Storage arrangements for the fluoride chemical compounds fed were unsatisfactory at six (33 percent) of the installations surveyed. The principle deficiency was the need to store the chemicals off the floor to reduce possible damage from flooding and absorbance of moisture. Three (17 percent) of the operators interviewed did not have available suitable safety equipment to handle fluoride chemical compounds. Disposal of the empty chemical shipping containers was satisfactory at all the sites visited.

One community, Rapid City, was having difficulty feeding the sodium silicofluoride recently purchased. The characteristics and packaging of the product, received from a foreign producer, varied from the product manufactured and sold as sodium silicofluoride in the U.S. When ordering fluoride chemical, the community should specify that the product meet the AWWA Standard for the chemical including material specifications, packaging and marking.

IV. Operator Training and Interest

A trained operator with a genuine interest in feeding fluorides is essential to the satisfactory operation of a fluoridation installation. Two (11 percent) of the facilities surveyed were operated by personnel not completely familiar with the fluoride chemical feed equipment at their plants and one (6 percent) of the operators was not adequately trained in the use of the fluoride ion test equipment provided and the procedures to follow in conducting fluoride ion analyses. The operators at four (22 percent) of the plants visited did not favor feeding fluorides to public water supply systems.

Nine of the eighteen selected installations were represented at the Fluoride Determinations in Water training course presented in Huron, S.D., November 1972. Generally better conditions were observed at those supplies which had operators in attendance at the course. Limited training in water fluoridation is also included in the yearly short schools conducted by the State Water Hygiene Program for operator certification.

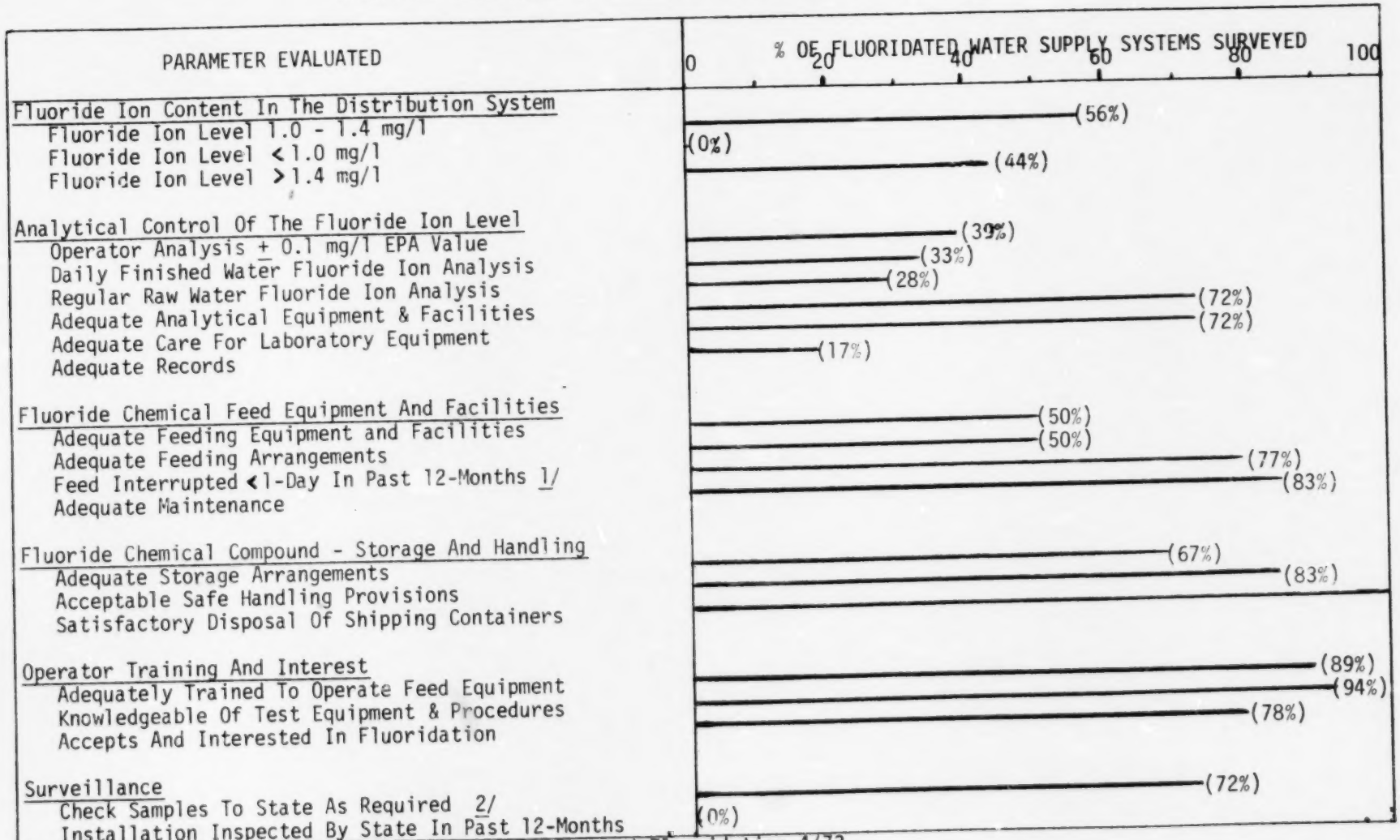
V. Surveillance

Frequent check samples of fluoride ion levels in the distribution system and regular inspection visits to the water fluoridation installation by State water supply surveillance personnel must be conducted to assure the facility is operating satisfactorily. The State requires fluoride check samples to be submitted to the State Laboratory on a frequency depending on the population served by the fluoridated community. Communities with populations greater than 10,000, 1 sample per week; 3,000 - 10,000, 2 per month; less than 3,000, one sample per month.

A review of the State Laboratory records for 1972 revealed the required number of check samples had not been received from five (28 percent) of the installations surveyed. Not one of the installations had been visited in the past twelve months by a representative of the State water supply surveillance agency. Inspection visits to the eighteen systems surveyed averaged one visit in 4.4 years. The Pierre installation had not been visited since June 1958.

Figure 2, Operating Conditions At Selected Fluoridated Water Supply Systems, summarizes the operating conditions observed at the installations inspected during the time of the survey. Conditions varied at each facility and Table V, Adequacy Of Fluoridation At Selected Fluoridated Water Supply Systems, summarizes the adequacy of the operating conditions at each facility during the time of the survey.

SOUTH DAKOTA FLUORIDATION PROGRAM EVALUATION
FIGURE 2
OPERATING CONDITIONS AT SELECTED FLUORIDATED WATER SUPPLY SYSTEMS



1/ Seventeen Installations Rated. Box Elder Started Fluoridating 4/73.
2/ Per 1972-73 Laboratory Records, South Dakota Dept. of Environmental Protection

SOUTH DAKOTA FLUORIDATION PROGRAM EVALUATION
TABLE V
ADEQUACY OF FLUORIDATION AT SELECTED WATER SUPPLY SYSTEMS

PARAMETER EVALUATED	Belle Fourche	Bowdle	Box Elder	Britton	Canistota	Custer	Mobridge	Parkston	Philip	Pierre	Rapid City	Sioux Falls	Spearfish	Sturgis	Volga	Watertown	Webster	Woonsocket
Fluoride Ion Content In The Distribution System																		
Fluoride Ion Level 1.0 - 1.4 mg/l	X	X	X	X	0	0	0	0	X	0	0	X	X	0	0	0	0	X
Fluoride Ion Level < 1.0 mg/l	X	X	X	X					X			X	X					X
Fluoride Ion Level > 1.4 mg/l																		
Analytical Control Of The Fluoride Ion Level																		
Operator Analysis ± 0.1 mg/l EPA Value	X	X	0	X	X	0	X	X	X	0	X	0	X	0	0	X	0	X
Daily Finished Water Fluoride Ion Analysis	X	X	X	X	X	0	X	0	0	X	0	0	X	X	X	X	0	X
Regular Raw Water Fluoride Ion Analysis	X	X	X	X	X	X	X	0	X	X	0	0	0	X	X	X	0	X
Adequate Analytical Equipment & Facilities	0	X	X	X	0	0	0	0	0	0	0	0	X	0	0	0	0	X
Adequate Care For Laboratory Equipment	0	0	0	X	0	X	0	0	0	X	0	0	X	0	0	0	X	0
Adequate Records	X	X	X	X	0	X	X	X	X	X	0	0	X	X	X	X	X	X
Fluoride Chemical Feed Equipment And Facilities																		
Adequate Feeding Equipment and Facilities	X	0	X	X	0	X	X	0	X	X	0	0	0	0	0	X	X	0
Adequate Feeding Arrangements	0	X	X	X	0	X	X	0	0	X	X	0	0	0	X	X	0	0
Feed Interrupted < 1-Day In Past 12-Months	0	0	2/	X	0	0	0	X	0	0	0	X	0	X	0	0	0	0
Adequate Maintenance	0	0	0	X	0	X	X	0	0	0	0	0	0	0	0	0	0	0
Fluoride Chemical Compound - Storage And Handling																		
Adequate Storage Arrangements	0	X	0	X	0	X	0	0	0	X	0	0	X	0	X	0	0	0
Acceptable Safe Handling Provisions	0	0	0	0	0	0	0	0	0	X	0	0	X	X	0	0	0	0
Satisfactory Disposal Of Shipping Containers	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Operator Training And Interest																		
Adequately Trained To Operate Feed Equipment	0	0	X	X	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Knowledgeable Of Test Equipment & Procedures	0	0	0	X	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Accepts And Interested In Fluoridation	X	X	0	X	0	0	0	0	0	0	0	0	0	0	X	0	0	0
Surveillance																		
Check Samples To State As Required 1/	0	0	0	0	X	0	X	X	0	0	X	0	X	0	0	0	0	0
Installation Inspected By State In Past 12-Months	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

0 - Satisfactory; X - Unsatisfactory
1/ Per 1972-73 Laboratory Records, South Dakota Dept. Of Environmental Protection
2/ Fluoridation Started 9/73. No Interruptions In Feed To Date Of Survey, 9/11/73.

Conclusions and Recommendations

1. Sixty-four public water supply systems in the State of South Dakota were fluoridating in September 1973, serving an estimated population of 327,900 (1970 Census). Twenty-seven communities, population 15,000 were using water sources containing natural fluorides within the recommended range (0.9 - 1.7 mg/l). Of the 276 reported public water supplies in the State, ninety-one (33 percent) were fluoridating or using one or more water sources containing natural fluorides within the recommended range.

Recommendation:

The South Dakota Department of Environmental Protection should promote the fluoridation of all public water supplies in the State not fluoridating or not containing dentally significant concentrations of natural fluorides. In communities where no public water supply systems exist, school fluoridation in that community should be considered if the available water sources do not contain natural fluorides of 0.9 mg/l or higher.

2. Sixty public water supplies in the State were reported using one or more water source containing natural fluorides greater than 2.4 mg/l or two times the recommended optimum level of 1.2 mg/l.

Recommendation

When the natural fluoride ion content in a public water supply exceeds two times the optimum, the following should be considered so the finished water will have a fluoride ion content within the limits recommended by the State: blending of water containing high levels of fluoride ion with a low natural fluoride water; development of an alternate source of water; or defluoridation of the water source.

3. Ten (56 percent) of the eighteen fluoridated water supply systems surveyed evidenced a fluoride ion content in the distribution system within the recommended limits of 1.0-1.4 mg/l fluoride. Only sixty-seven percent of the 534 fluoride check samples received by the State laboratory in the past year from the supplies surveyed were within the 1.0-1.4 mg/l range.

Recommendation

The South Dakota Department of Environmental Protection should more vigorously enforce their recommended fluoride standards at all fluoridated water supplies since a reduction of as little as 0.2 mg/l below the recommended optimum level can reduce the benefits by 50 percent.

4. Only seven (39 percent) of the plant operators or laboratory personnel testing water samples for fluoride ion content conducted the analysis within ± 0.1 mg/l of the sample results analyzed by the EPA. Daily finished water fluoride ion analysis required in the State Health Department Regulation 2.17 was conducted at six (33 percent) of the installations and the source of raw water was analyzed on a regular basis at five (28 percent). Records were satisfactory at only three (17 percent) of the plants.

   Recommendation

   The South Dakota Department of Environmental Protection should require the operators of all fluoridation installations to conduct fluoride ion analyses according to Standard Methods to within ± 0.1 mg/l of the value reported on the State check sample. Daily finished water fluoride ion analysis, regular raw water fluoride ion analysis, adequate laboratory equipment and care of equipment, and complete records on the fluoridation operation should be enforced at all fluoridation installations.

5. Fluoride chemical feed equipment, facilities and feed arrangements were satisfactory at nine (50 percent) of the plants surveyed. Four (23 percent) of the installations reported one or more interruptions in the fluoridation operation of one or more days duration in the past twelve months and maintenance was less than satisfactory at three (17 percent) of the facilities.

Recommendation

The South Dakota Department of Environmental Protection should develop specific regulations for the installation of fluoridation equipment in the State, thoroughly review all proposed installations before the operation is approved, and assist the operator as needed during the "start-up" period. All interruptions should be required to be reported to the State. A preventive maintenance program should be established for each facility and closely followed for the installation to receive continued approval for operation.

6. Fluoride chemical storage arrangements were inadequate at six (33 percent) of the installations and three (17 percent) of the operators interviewed did not have available suitable safety equipment to handle the fluoride compounds used. Variation in chemical characteristics of the fluoride compound recently purchased at Rapid City was causing problems in feeding fluorides at the plant.

Recommendation

The South Dakota Department of Environmental Protection should promulgate regulations for storage and handling fluoride chemical compounds used in water fluoridation in the State, and should provide to all water plant operators feeding fluorides, training in safe handling practices. Communities ordering fluoride chemicals should specify that the product meet the AWWA Standard for the chemical including material specifications, packaging and marking.

7. A trained operator with a genuine interest in feeding fluorides is essential to the satisfactory operation of a fluoridation installation. Training deficiencies were noted in the operator's knowledge of his fluoride feed equipment and his acquaintance with the equipment and procedures used in conducting fluoride ion analysis. Four (22 percent) of the operators interviewed did not favor feeding fluorides to public water supply systems.

Recommendation

The South Dakota Department of Environmental Protection should expand their training program to include training in fluoride feed equipment operation and maintenance and fluoride determinations in water for the operators of all fluoridated water supply systems. The benefits of water fluoridation and the importance of maintaining an optimum level of fluoride ion in the distribution system at all times should be stressed. Satisfactory completion of the training should be a mandatory requirement of each plant operator for approval of his installation to feed fluorides.

8. Surveillance of each water fluoridation installation must be on a regular, continual basis to assure the facility is operating satisfactorily. Five (28 percent) of the operators interviewed had not submitted to the State Laboratory in the past year the required number of check samples for fluoride ion analysis. Not one of the installations surveyed had been visited in the past year by a representative of the State water supply surveillance agency.

Recommendation

The South Dakota Department of Environmental Protection should enforce their regulations for the submission of fluoride check samples to the State Laboratory. Inspection visits to each fluoridation installation in the State should be scheduled once each year. Interruptions in the fluoridation feed operations at any plant or any variation in check sample results greater than ± 0.1 mg/l should be investigated. All plants employing new operating personnel placed in charge of the fluoridation operation should be visited immediately to assure the new operator has been adequately trained.

9. The proven benefits in dollars derived from fluoridation to prevent dental caries for the population in South Dakota presently served by fluoridated water are estimated to be $3.0 million annually. The annual cost to the sixty-four communities to fluoridate their water is estimated at $52,500 and the annual cost to the State for implementing a satisfactory fluoridation program is estimated at $50,000, giving a benefit cost ratio to the State of 29 to 1.

Recommendation

The South Dakota Department of Environmental Protection should supplement their existing fluoridation program effort by the assignment to this activity of one additional engineer full time with the necessary travel funds and laboratory support.

APPENDICES

A. South Dakota Fluoridation Law

B. Letter dated January 18, 1973, from Charles E. Carl, Director, Division of Sanitary Engineering and Environmental Protection, South Dakota Department of Health, to John A. Green, Regional Administrator, Environmental Protection Agency, Region VIII, requesting evaluation of the South Dakota Fluoridation Program.

C. Fluoridation of Water, SDCL Chapter 34-24 A.

D. Fluoridation of Municipal Water Supplies, South Dakota State Department of Health Regulation 2.17.

E. Natural Fluoride Levels, South Dakota Community Water Supply Systems.

F. Water Supply Systems Containing Excessive Levels of Fluorides.

G. Fluoridation Benefits in South Dakota - Calculations.

H. Questionnaire used in the South Dakota Fluoridation Survey.

Appendix A

SOUTH DAKOTA FLUORIDATION LAW

Approved March 25, 1969

AN ACT ENTITLED, AN ACT RELATING TO PUBLIC HEALTH; REQUIRING FLUORIDATION OF SOUTH DAKOTA MUNICIPAL WATER SUPPLIES; PRESCRIBING THE POWERS AND DUTIES OF THE SOUTH DAKOTA STATE DEPARTMENT OF HEALTH IN RELATION THERETO.

Be It Enacted by the Legislature of the State of South Dakota:

For the purpose of promoting Public Health through prevention of tooth decay any person, firm, corporation or municipality having jurisdiction over a municipal water supply, whether publicly or privately owned or operated, shall control the quantities of fluoride in the water so as to maintain a minimum fluoride content prescribed by the South Dakota State Department of Health. The South Dakota State Department of Health shall promulgate rules and regulations relating to the fluoridation of public water supplies which shall include, but not be limited to the following: (1) the means by which fluoride is controlled; (2) the methods of testing the fluoride content; and (3) the records to be kept relating to fluoridation. The State Department of Health shall enforce the provisions of the section. In so doing it shall require the fluoridation of water in all municipal water supplies serving a population of 3,000 or more by July 1, 1970, serving a population of 1,000 to 3,000 by July 1, 1971 and serving a population of 500 to 1,000 by July 1, 1972. The State Department of Health shall not require the fluoridation of water in any municipal water supply where such water supply in the state of nature contains sufficient fluorides to conform with the rules and regulations of such Department.

South Dakota

State Department of Health

ROBERT H. HAYES, M.D., STATE HEALTH OFFICER

Pierre

January 18, 1973

In Reply II-A
Refer to: South Dakota Fluoridation
Program Evaluation

John A. Green
Regional Administrator
Environmental Protection Agency
900 Lincoln Tower Building
1860 Lincoln Street
Denver, Colorado 80203

Dear Mr. Green:

This office has the responsibility for enforcement of the State Fluoridation Law which requires fluoridation of all public water supplies in South Dakota above 500 population. Eighty-four cities with a total population of 342,000 are involved in the State Fluoridation Program. Because of dental health aspects of fluoridation, the enforcement and surveillance of this State Law is an important part of the Water Hygiene Program in South Dakota.

We expect to have all cities in compliance with the Law in about four months. With compliance, we would then like to have an outside agency evaluate the South Dakota Fluoridation Program.

It is therefore requested that the Environmental Protection Agency through the Division of Water Hygiene conduct an evaluation of the South Dakota Fluoridation Program. We would suggest a date sometime during the fall of 1973.

Very truly yours,

Charles E. Carl

Charles E. Carl, Director
Division of Sanitary Engineering
and Environmental Protection

CEC:ks

Appendix C

Chapter 34-24A

FLUORIDATION OF WATER

34-24A-1. Duty of control of fluoride content in municipal water supply.--For the purpose of promoting public health through prevention of tooth decay any person, firm, corporation or municipality having jurisdiction over a municipal water supply, whether publicly or privately owned or operated, shall control the quantities of fluoride in the water so as to maintain a minimum fluoride content prescribed by the South Dakota state department of health.

34-24A-2. Rules and regulations relating to fluoridation of water supplies.--The South Dakota state department of health shall promulgate rules and regulations relating to the fluoridation of public water supplies which shall include, but not be limited to the following:

(1) The means by which fluoride is controlled;

(2) The methods of testing the fluoride content; and

(3) The records to be kept relating to fluoridation.

34-24A-3. Enforcement of fluoridation requirements--Time for fluoridation of municipal water supplies--Exemption from fluoridation requirement.--The state department of health shall enforce the provisions of § 34-24A-1 and § 34-24A-2. In so doing it shall require the fluoridation of water in all municipal water supplies serving a population of three thousand or more by July 1, 1970, serving a population of one thousand to three thousand by July 1, 1971 and serving a population of five hundred to one thousand by July 1, 1972. The state department of health shall not require the fluoridation of water in any municipal water supply where such water supply in the state of nature contains sufficient fluorides to conform with the rules and regulations of such department.

****

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Appendix D

SOUTH DAKOTA STATE DEPARTMENT OF HEALTH

FLUORIDATION OF MUNICIPAL WATER SUPPLIES

Regulation 2.17

Effective January 27, 1970

This regulation is issued by the South Dakota State Department of Health under the authority set forth in SDCL Chapter 34-24A and SDCL Chapter 34-1 and in accordance with the procedures set forth in SDCL Chapter 1-26.

The following members, being a quorum for the transaction of business, completed voting by mail December 30, 1969:

L. P. Mills, D.O., Platte
John Venners, D.V.M., Plankinton
Walter H. Morgans, D.D.S., Aberdeen
Mrs. Margaret Cashman, R.N., Sioux Falls
Vere Larsen, Alcester
Allen Bronson, D.C., Jefferson
Dale Garris, Chamberlain
Robert H. Quinn, M.D., Sioux Falls

IT WAS VOTED TO ADOPT THE REGULATION AS FOLLOWS:

2.17 FLUORIDATION OF MUNICIPAL WATER SUPPLIES

2.17.1 Definitions:

2.17.1.1 Municipal Water Supplies - shall mean any water supply operated by a person, firm, corporation, municipality, or sanitary district serving a population of 500 or more people.

2.17.1.2 State Health Officer - shall mean the duly appointed State Health Officer of the State Department of Health or his authorized representative.

2.17.1.3 State Department of Health - Department created by SDCL Chapter 34-1.

2.17.1.4 Milligrams per liter - a method of expressing analytical results. For purposes of the regulation milligrams per liter (mg/l) is equivalent to parts per million (ppm) by weight.

2.17.2 Written approval is required by the South Dakota Department of Health of proposals for addition of fluoride ion to municipal water supplies. Plans and specifications shall be submitted as prescribed by Regulation No. 2.1.

Fluoridation installations other than on municipal supplies are to be in compliance with this regulation.

A variance to this requirement may be allowed by the State Health Officer for installations costing less than $1,000.

2.17.3 Where the average natural fluoride ion content of the water from any source for a municipal water supply is less than 0.9 mg/l, equipment shall be provided and operated to adjust the fluoride ion concentration in the range of 0.9 mg/l to 1.7 mg/l, with an average level of 1.2 mg/l.

Those municipal water supplies with fluoride ion concentrations in excess of 1.7 mg/l should consult with the South Dakota Department of Health relative to procedures for reducing the fluoride ion content to an optimum amount.

2.17.4 The chemical feeder apparatus for introducing fluoride ion into the water supply shall be constructed, installed, and operated in accordance with the standards of the State Department of Health.

2.17.5 Testing equipment shall be available for determing the fluoride content at each installation. The fluoride content shall be determined each day on a representative sample of fluoridated water.

A variance to this requirement may be allowed by the State Health Officer upon request and submission of evidence that other testing procedures are satisfactory.

2.17.6 Representative samples shall be collected from the distribution system and submitted to the State Department of Health Laboratory in Pierre for testing - in accord with the following schedule:

(a) Population over 10,000 - one sample per week.

(b) Population of 3,000-10,000 - two samples per month (one sample the first week of the month and the second sample the third week of the month).

(c) Population less than 3,000 - one sample each month.

2.17.7 Daily records of the fluoride content of the distribution system shall be maintained by the water system owners or their representatives. These records shall show the amount of fluoride chemical fed to the system, fluoride test results, amount of water pumped, and any other pertinent information as required by the State Department of Health. These records are to be available for review by the State Health Officer.

G. J. Van Heuvelen, M.D.
State Health Officer

Appendi: E

Natural Fluoride Levels

South Dakota Community Water Supply Systems (a)

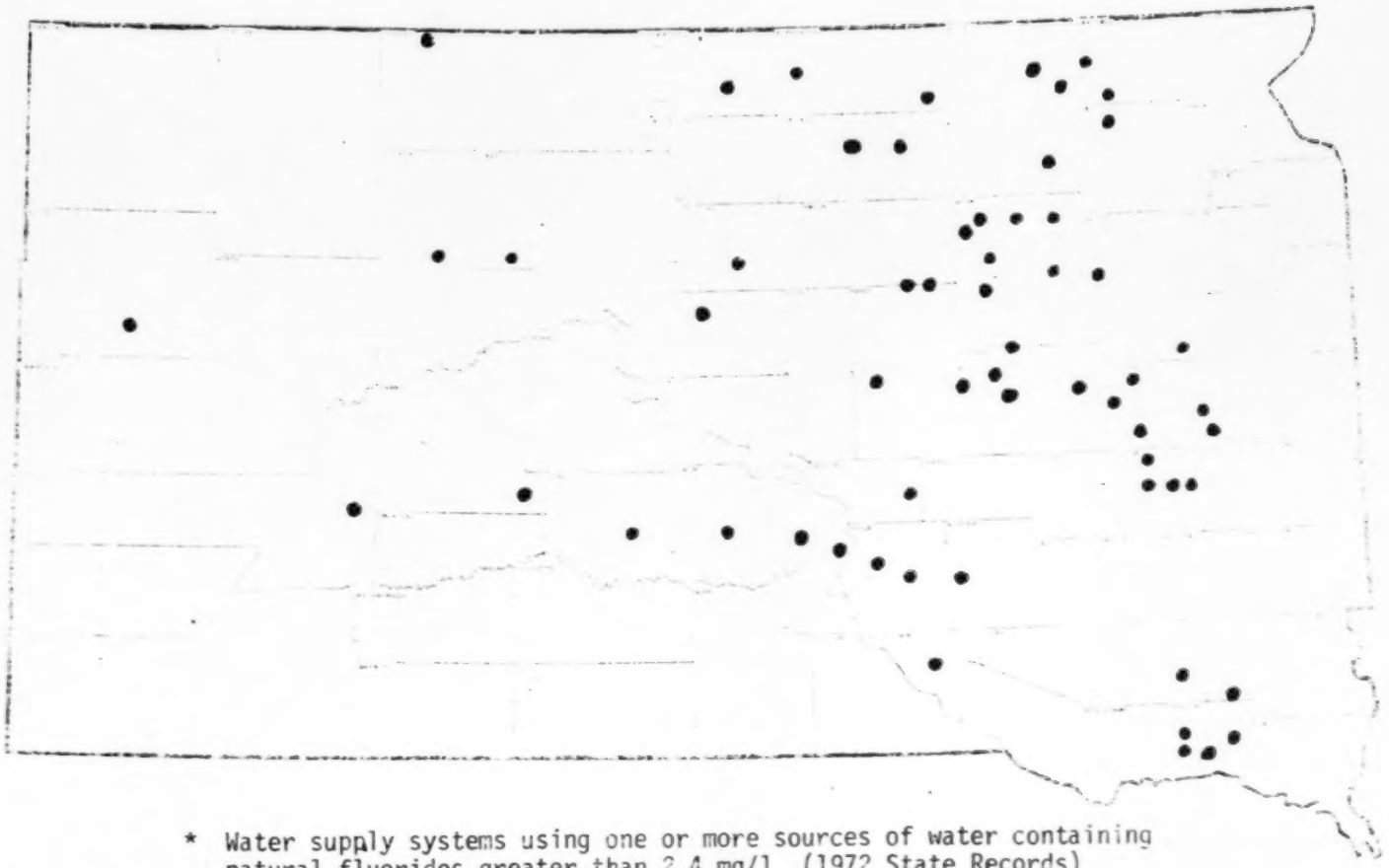
Water Supply System	1970 Population	Natural Fluoride Level, mg/l 0.9-1.7	1.8-2.4	>2.4 (b)
Agar	156			x
Alexandria	598		x	
Alpena	307		x	
Amherst	75			x
Armour	925	x		
Ashton	137			x
Bancroft	48			x
Belvidere	96		x	
Bison	406		x	
Brentford	94			x
Broadland	45			x
Bryant	502			x
Canova	204	x		
Canton	2665	x		
Carthage	362			x
Cavour	134	x		
Chancellor	220	x		
Claremont	214			x
Colome	375	x		
Conde	279			x
Corsica	615		x	
Cresbard	224		x	
Crooks Sanitary District	202	x		
Delmont	260		x	
Doland	430			x
Draper	200			x
Dupree	523			x
Eagle Butte	503			x
Edgemont	1174	x		
Esmond	19			x
Ethan	309	x		
Eureka	1547			x
Ferney	47			x
Forestburg	105		x	
Frankford	192		x	
Furitdale	74	x		
Gann Valley	75			x
Geddles	308	x		
Gettysburg	1915			x
Groton	1021		x	
Hitchcock	150			x
Houghton	102			x
Howard	1175			x
Ipswich	1187			x
Iroquois	375			x
Kadoka	815	x		
Kimball	825			x
Lake Preston	812			x
Lane	94		x	
Langford	328			x
Lennon	1997	x		
Leola	787		x	
Lesterville	181			x
Letcher	201		x	
Marion	844	x		
Mansfield	130		x	
Mc Intosh	563	x		
Meadow	8	x		
Mellette	199			x
Menno	796			x
Midland	270			x
Miller	2148		x	
Mission Hill	161			x
Morristown	144			x
Mound City	164			x
Mount Vernon	398		x	
Newell	664			x
North Sioux City	860	x		
Northville	119			x
Oacoma	215			x
Oldham	244			x
Onida	785		x	
Orient	131			x
Pierpont	241			x
Plankinton	613	x		
Platte	1351			x
Presho	922			x
Pukwana	208			x
Quinn	105			x
Ramona	227		x	
Raymond	114			x
Redfield	2943			x
Ree Heights	183			x
Reliance	204			x
Rockham	60			x
Roscoe	398			x
Roswell	32			x
Sinai	147	x		
Stickney	421	x		
Stratford	106	x		
Tabor	388	x		
Tolstoy	99	x		
Tripp	851	x		
Tulare	211		x	
Utica	89			x
Viborg	622			x
Vilas	33			x
Virgil	43		x	
Vivian	190	x		
Volin	157			x
Wall	786		x	
Wentworth	196	x		
Wessington	380			x
Wetonka	31			x
White Lake	395			x
Wolsey	436			x
Worthing	294	x		
Yale	148			x

(a) Water supply systems using one or more water sources containing natural fluorides of 0.9 mg/l or higher (State Records, 1972)
(b) Two times the State recommended optimum level of 1.2 mg/l

Appendix F

SOUTH DAKOTA FLUORIDATION PROGRAM EVALUATION

Water Supply Systems Containing Excessive Levels of Fluorides *



* Water supply systems using one or more sources of water containing natural fluorides greater than 2.4 mg/l (1972 State Records)

APPENDIX G

FLUORIDATION BENEFITS IN SOUTH DAKOTA - CALCULATIONS

Population Served by Fluoridated Water - 327,900
(1970 Census for communities reported fluoridating)

Average Annual Cost to Communities Fluoridating - $0.16/capita/year
("Fluoridation of Public Water Supplies" -
New York State Department of Health)

Total Annual Cost of Fluoridation in South Dakota
to Communities Fluoridating:

327,900 X $0.16 = $52,500/year

Average Annual Benefit of Fluoridation to Communities Fluoridating -
$58/yr/dollar spent on fluoridation
("The Economics of Fluoridation" - DDH, PPB #31, USPHS)

52,500 X $58 = $3,045,000/yr or $3.0 X 10^6

Total Annual Cost to the State for Fluoridation Surveillance -

1.5 man years + travel @ $30,000/man yr = $45,000

Laboratory support -

64 installations, 25 samples/installation, $3.00/sample

64 X 25 X $3.00 = $ 4,800

TOTAL $49,800 or $50,000

Benefit Cost Ratio:

$$\frac{\text{Annual Benefit of Fluoridation}}{\text{Annual Cost to Communities + Annual Cost to State}} = \frac{3.0 \times 10^6}{\$52,500+\$50,000} \text{ or } 29:1$$

DATE: _____

Appendix H

SOUTH DAKOTA FLUORIDATION SURVEY

Water System:

Population Served: Average Flow:

Date Fluoridation Started:

Source of Supply:

Treatment:

Fluoride Analysis:
Raw Water: Finished Water:

Fluoridation Equipment -

Manufacturer:

Type:

Model:

Location:

Point of Application:

Condition of Equipment:

Operational Problems:

Overfeeding Safeguards:

Planned Improvements:

Remarks:

Fluoride Compound -

Chemical: Cost:

Source:

Form of Shipment

Storage Facilities:

Quantity Used:

Safety Provisions:

Disposal of Containers:

Remarks:

Control of Fluoridation -

Frequency of Sampling:
Raw Water: Finished Water:

Sampling Point:

Test Method:

Test Instrument:
Adequacy

Condition

Records:
Calculated

Lab

Interruptions:

Remarks:

Operator Qualifications -

Experience: Classification:

Training:

Interest:

Remarks:

Surveillance -

Check Samples:

Last Visit by State:

Availability of Technical Assistance:

Remarks:

Comments -

SOUTH DAKOTA FLUORIDATION PROGRAM EVALUATION
Table 1
Fluoridated Water Supply Systems In South Dakota

Water Supply System	Location (County)	Date Fluoridation Started	1970 Census Population
Aberdeen	Brown	2/51	26,476
Belle Fourche	Butte	1/71	4,236
Beresford	Union	7/71	1,655
Bowdle	Edmunds	7/72	667
Box Elder	Pennington	4/73	607
Brandon Water Co.	Minnehaha	1/71	1,431
Bridgewater	McCook	10/72	633
Britton	Marshall	6/71	1,465
Brookings	Brookings	12/61	13,717
Burke	Gregory	5/72	892
Canistota	McCook	10/72	636
Castlewood	Hamlin	4/73	523
Centerville	Turner	7/73	910
Chamberlain	Brule	7/71	2,626
Clark	Clark	11/71	1,356
Clear Lake	Deuel	11/71	1,157
Custer	Custer	8/71	1,597
Dell Rapids	Minnehaha	8/71	1,991
DeSmet	Kingsbury	10/71	1,336
Estelline	Hamlin	10/72	624
Faith	Meade	6/72	576
Flandreau	Moody	9/71	2,027
Fort Pierre	Stanley	3/72	1,448
Freeman	Hutchinson	1/72	1,357
Gregory	Gregory	7/69	1,756
Hartford	Minnehaha	1/73	800
Highmore	Hyde	1/72	1,173
Hosmer	Edmunds	4/57	437
Hot Springs	Fall River	10/70	4,434
Hoven	Potter	7/72	671
Huron	Beadle	9/56	14,299
McCook Lake	Union	10/72	806
Lake Andes	Charles Mix	1/72	948
Lead - Deadwood	Lawrence	10/70	5,420 2,409
Madison	Lake	5/70	6,315
Martin	Bennette	11/71	1,248
McLaughlin	Corson	10/72	863
Milbank	Grant	4/68	3,727
Mitchell	Davidson	11/54	13,425
Mobridge	Walworth	3/52	4,545
Murdo	Jones	9/72	865
Parker	Turner	1/69	1,005
Parkston	Hutchinson	1/72	1,611
Philip	Haakon	5/72	983
Pierre	Hughes	8/68	9,699
Rapid City	Pennington	8/70	43,836
Rapid Valley Water Service Company	Pennington	7/71	1,800
Salem	McCook	3/71	1,391
Scotland	Bon Homme	8/72	964
Selby	Walworth	5/72	957
Sioux Falls	Minnehaha	10/70	72,488
Sisseton	Roberts	4/72	3,094
Spearfish	Lawrence	11/70	4,661
Springfield	Bon Homme	6/67	1,566
Sturgis	Meade	12/70	4,536
Vermillion	Clay	10/51	9,128
Volga	Brookings	4/72	982
Wagner	Charles Mix	7/71	1,655
Watertown	Codington	9/53	13,388
Webster	Day	1/70	2,252
Wessington Springs	Jerauld	5/66	1,300
Winner	Tripp	8/70	3,789
Woonsocket	Sanborn	5/72	852
Yankton	Yankton	11/70	11,919

SOUTH DAKOTA FLUORIDATION PROGRAM EVALUATION
TABLE II
FLUORIDATED WATER SUPPLY SYSTEMS SELECTED FOR STUDY

Water Supply System	Population Served	Source of Supply	Avg. Use (MGD) 1/	Fluoride Compound	Type of Feeder	Analysis Method	Test Equipment
Belle Fourche	4,500	Infiltration Gallery	0.5 W 2.5 S	VT	PS-1	S	T-1
Bowdle *	700	5 - Wells	0.05 W 0.17 S			S	T-1
Well #1				VT	PS-2		
2				VT	PS-2		
3 & 4				VT	PS-2		
6				VT	PS-2		
Box Elder	1,700	2 - Wells	0.06 W 0.08 S			S	T-1
Well #1				VT	PS-3		
2				VT	PS-3		
Britton	1,450	White Lake	0.16 W 0.28 S	VA	P-1	S	T-1
Canistota *	600	2 - Wells	0.05 W 0.06 S	VT	PS-2	S	T-1
Custer	1,800	3 - Wells	0.15 W 0.25 S			S	T-1
Well #2				VT	PS-3		
4				VT	PS-3		
5				VT	PS-3		
Mobridge	4,900	Oahe Reservoir	0.30 W 1.50 S	VT	V-1	S	T-1
Parkston *	1,600	2 - Wells	0.18 W 0.30 S	VT	PS-4	S	T-1
Philip *	1,400	Lake Waggoner & Artesian Well	0.12 W 0.30 S	VT	PS-8	S	T-1
Pierre	9,800	8 - Wells	1.70			S	T-1
Well #1				VA	P-1		
2				VA	P-1		
3				VA	P-1		
4				VA	P-1		
5				VA	P-1		
6				VA	P-1		
7				VA	P-1		
8				VA	P-1		
Rapid City *	49,000	Rapid Cr., 2-Infiltration Galleries, Jackson Spr.	7.30			S	T-1
Rapid Creek				VS	V-2		
Girl Scout				VS	V-3		
Meadowbrook				VS	V-3		
Jackson Spring				VS	V-3		
Sioux Falls *	80,000	30 - Wells & Sioux R.	11.0 W 18.0 S	VS	G-1	S	T-2
Spearfish	6,400	Spearfish Cr., Spearfish Spr., 1 - Well	1.1 W 2.4 S			S	T-1
Spearfish Canyon Cr.				VT	PS-1		
Spearfish Park Spr.				VT	PS-1		
Dickey Well				VT	PS-1		
Sturgis	5,000	3 - Wells, Warren Cr.	0.40 W 0.98 S			S	T-1
Well #1 & 3				VT	PS-5		
Warren Creek				VT	PS-1		
Well #2				VT	PS-5		
Volga *	1,000	5 - Wells	0.20			S	T-1
Well #2				VT	PS-6		
3				VT	PS-7		
4				VT	PS-6		
5				VT	PS-2		
6				VT	PS-2		
Watertown	14,600	8 - Wells, Lake Kampeska	2.0			S	T-3
Plant #1 (5 wells)				VS	V-2		
Kampeska				VS	V-3		
Well #4				VT	PS-2		
5				VT	PS-2		
8				VT	PS-4		
Webster *	2,200	5 - Wells	0.16 W 0.35 S	VT	PS-5	S	T-1
Woonsocket *	800	2 - Wells	0.04 W 0.07 S			S	T-1
Well #1				VT	PS-2		
2 2/							

Fluoride Compound
VA - Fluosilicic Acid
VS - Sodium Silicofluoride
VT - Sodium Fluoride

Analysis Method
S - Spadns

Type of Feeder
G-1 Gravimetric - BIF 31-12 Loss-in-Weight
P-1 Diaphram Pump - W & T A-747
V-1 Volumetric - BIF 50-A Rotating Disk
V-2 Volumetric - W & T A-690 Screw Type
V-3 Volumetric - W & T A-378 Roll Type
PS-1 Diaphram Pump - W & T A-747, Saturator
PS-2 Diaphram Pump - W & T 94-100, Saturator
PS-3 Diaphram Pump - W & T A-748, Saturator
PS-4 Diaphram Pump - W & T A-416, Saturator
PS-5 Diaphram Pump - W & T A-745, Saturator
PS-6 Diaphram Pump - F & P 71 R 2000, Saturator
PS-7 Diaphram Pump - PCP Models, Saturator

Test Equipment
T-1 Photometer - Hach DR
T-2 Spectrophotometer - B & L Spectronic 20
T-3 Spectrophotometer - Hach DR/2

* Representative Attended Fluoride Determinations in Water Training Course, Huron, S.C., Nov. 28-30, 1972.

1/ W-Winter; S-Summer
2/ Supply Not Fluoridated

Appendix E

Natural Fluoride Levels

South Dakota Community Water Supply Systems (a)

Water Supply System	1970 Population	Natural Fluoride Level, mg/l 0.9-1.7	1.8-2.4	>2.4 (b)
Agar	156			x
Alexandria	598		x	
Alpena	307		x	
Amherst	75			x
Armour	925	x		
Ashton	137			x
Bancroft	48			x
Belvidere	96		x	
Bison	40[c]		x	
Brentford	94			x
Broadland	45			x
Bryant	502			x
Canova	204	x		
Canton	2665	x		
Carthage	362			x
Cavour	134	x		
Chancellor	220	x		
Claremont	214			x
Colome	375	x		
Conde	279			x
Corsica	615		x	
Cresbard	224		x	
Crooks Sanitary District	202	x		
Delmont	260		x	
Doland	430			x
Draper	200			x
Dupree	523			x
Eagle Butte	503			x
Edgemont	1174	x		
Esmond	19			x
Ethan	309	x		
Eureka	1547			x
Ferney	47			x
Forestburg	105		x	
Frankford	192		x	
Furtdale	74	x		
Gann Valley	75			x
Geddes	308	x		
Gettysburg	1915			x
Groton	1021		x	
Hitchcock	150			x
Houghton	102			x
Howard	1175			x
Ipswich	1187			x
Iroquois	375			x
Kadoka	815	x		
Kimball	825			x
Lake Preston	812			x
Lane	94		x	
Langford	328			x
Lemmon	1997	x		
Leola	787		x	
Lesterville	181			x
Letcher	201		x	
Marion	844	x		
Mansfield	130		x	
Mc Intosh	563	x		
Meadow	8	x		
Mellette	199			x
Menno	796			x
Midland	270			x
Miller	2148		x	
Mission Hill	161			x
Morristown	144			x
Mound City	164			x
Mount Vernon	398		x	
Newell	664			x
North Sioux City	860	x		
Northville	119			x
Oacoma	215			x
Oldham	244			x
Onida	785		x	
Orient	131			x
Pierpont	241			x
Plankinton	613	x		
Platte	1351			x
Presho	922			x
Pukwana	208			x
Quinn	105			x
Ramona	227		x	
Raymond	114			x
Redfield	2943			x
Ree Heights	183			x
Reliance	204			x
Rockham	60			x
Roscoe	398			x
Roswell	32			x
Sinai	147	x		
Stickney	421	x		
Stratford	106	x		
Tabor	388	x		
Tolstoy	99	x		
Tripp	851	x		
Tulare	211		x	
Utica	89			x
Viborg	622			x
Vilas	33			x
Virgil	43		x	
Vivian	190	x		
Volin	157			x
Wall	786		x	
Wentworth	196	x		
Wessington	380			x
Wetonka	31			x
White Lake	395			x
Wolsey	436			x
Worthing	294	x		
Yale	148			x

(a) Water supply systems using one or more water sources containing natural fluorides of 0.9 mg/l or higher (State Records, 1972)
(b) Two times the State recommended optimum level of 1.2 mg/l

SOUTH DAKOTA FLUORIDATION PROGRAM EVALUATION
TABLE III
ANALYSIS OF SAMPLES FROM SELECTED FLUORIDATED WATER SUPPLY SYSTEMS

Water Supply System	Date of Sample	Fluoride Content, mg/l					
		Raw Water	Check Sample Operator	Check Sample State	Check Sample EPA	Distribution System	
Belle Fourche	9/13	0.25	>2.0	2.88	2.90	1.76	2.90
Bowdle	10/15		1.4	1.85	1.80	1.45	1.80
Well #1							
2		0.34					
3 & 4							
6							
Box Elder	9/11		1.6	1.71	1.70	1.55	1.70
Well #1		0.49					
2		0.69					
Britton	10/16	0.24	1.3	1.45	1.43	1.47	1.50
Canistota	10/18	0.55	2.0	1.61	1.58	1.28	1.27
Custer	9/14		1.2		1.30	1.23	1.23
Well #2		*		1.20	1.23		
4		*					
5		*					
Mobridge	10/15	0.52	1.5	1.35	1.24	1.33	1.14
Parkston	10/18	0.58	1.62	1.19	1.28	1.28	1.28
Philip	9/14		1.7		2.20	1.49	
Lake Waggoner		0.45		1.47	1.49		
Artesian Well		1.98					
Pierre	9/10		1.31		1.22	1.28	1.22
Well #1		*		1.38	1.37	1.22	1.37
2		*					
3		*					
4		*					
5		*					
6		*					
7		*					
8		*					
Rapid City	9/11		1.35	1.09	1.06	1.17	1.23
Rapid Creek		0.28				1.27	
Girl Scout		0.32					
Meadowbrook		0.31					
Jackson Spring		0.27					
Sioux Falls	10/19	0.30	1.42	1.27	1.33	1.45	1.48
				1.3 **	1.36	1.45	
Spearfish	9/12		1.6	1.46	1.40	1.40	1.44
Spearfish Canyon Cr.		0.31					
Spearfish Park Spr.		0.23					
Dickey Well		0.28					
Sturgis	9/13		1.17	1.20	1.14	1.24	1.14
Well #1		*					
3		0.29					
Warren Creek		*					
Well #2		0.22					
Volga	10/17		> 2.0	1.98	2.03	1.06	1.17
Well # 2		*					
3		*					
4		*					
5		*					
6		*					
Watertown	10/17		1.36	1.15	1.22	1.25	1.37
Plant #1 (5 wells)		0.22					
Kampeska		0.24					
Well #4		*					
5		*					
8		*					
Webster	10/16	0.46	1.26	1.08	1.17	1.22	1.17
Woonsocket	10/18		1.6	1.30	1.40	1.41	1.43
Well #1		0.75					
2		*					

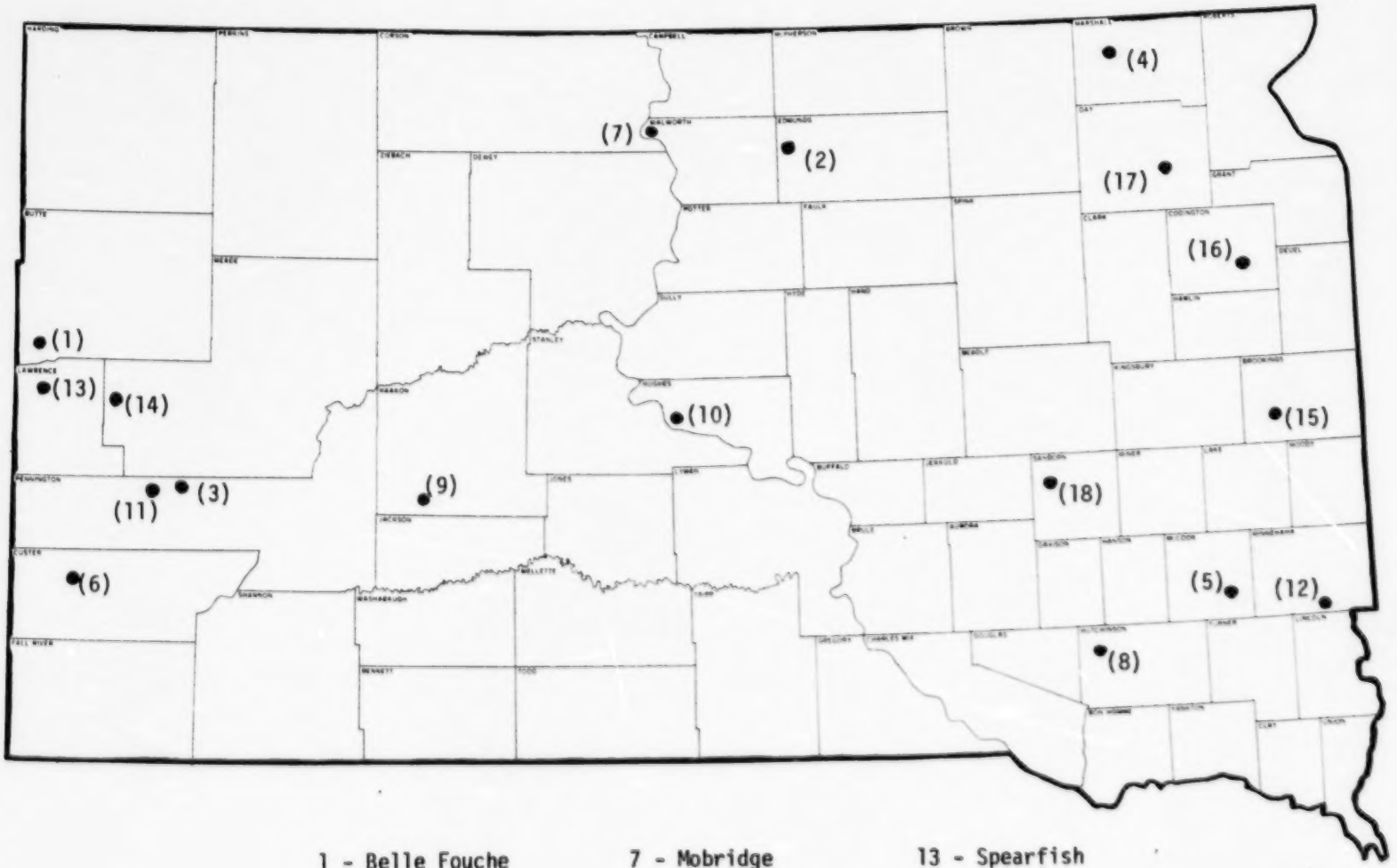
* No Raw Water Sampling Point
** Sioux Falls Health Department Laboratory

SOUTH DAKOTA FLUORIDATION PROGRAM EVALUATION
TABLE V
ADEQUACY OF FLUORIDATION AT SELECTED WATER SUPPLY SYSTEMS

PARAMETER EVALUATED	Belle Fourche	Bowdle	Box Elder	Britton	Canistota	Custer	Mobridge	Parkston	Philip	Pierre	Rapid City	Sioux Falls	Spearfish	Sturgis	Volga	Watertown	Webster	Woonsocket
Fluoride Ion Content In The Distribution System																		
Fluoride Ion Level 1.0 - 1.4 mg/l	X	X	X	X	0	0	0	0	X	0	0	X	X	0	0	0	0	X
Fluoride Ion Level < 1.0 mg/l	X	X	X	X					X			X	X					X
Fluoride Ion Level > 1.4 mg/l																		
Analytical Control Of The Fluoride Ion Level																		
Operator Analysis ± 0.1 mg/l EPA Value	X	X	0	X	X	0	X	X	X	0	X	0	X	0	0	X	0	X
Daily Finished Water Fluoride Ion Analysis	X	X	X	X	X	0	X	0	0	X	0	0	X	X	X	X	0	X
Regular Raw Water Fluoride Ion Analysis	X	X	X	X	X	X	X	0	X	X	0	0	0	X	X	X	0	X
Adequate Analytical Equipment & Facilities	0	X	X	X	0	0	0	0	0	0	0	0	X	0	0	0	0	X
Adequate Care For Laboratory Equipment	0	0	0	X	0	X	0	0	0	X	0	0	X	0	0	0	X	0
Adequate Records	X	X	X	X	0	X	X	X	X	X	0	0	X	X	X	X	X	X
Fluoride Chemical Feed Equipment And Facilities																		
Adequate Feeding Equipment and Facilities	X	0	X	X	0	X	X	0	X	X	0	0	0	0	0	X	X	0
Adequate Feeding Arrangements	0	X	X	X	0	X	X	0	0	X	X	0	0	0	X	X	0	0
Feed Interrupted < 1-Day In Past 12-Months	0	0	2/	X	0	0	0	X	0	0	0	X	0	X	0	0	0	0
Adequate Maintenance	0	0	0	X	0	X	X	0	0	0	0	0	0	0	0	0	0	0
Fluoride Chemical Compound - Storage And Handling																		
Adequate Storage Arrangements	0	X	0	X	0	X	0	0	0	X	0	0	X	0	X	0	0	0
Acceptable Safe Handling Provisions	0	0	0	0	0	0	0	0	0	X	0	0	X	X	0	0	0	0
Satisfactory Disposal Of Shipping Containers	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Operator Training And Interest																		
Adequately Trained To Operate Feed Equipment	0	0	X	X	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Knowledgeable Of Test Equipment & Procedures	0	0	0	X	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Accepts And Interested In Fluoridation	X	X	0	X	0	0	0	0	0	0	0	0	0	0	X	0	0	0
Surveillance																		
Check Samples To State As Required 1/	0	0	0	0	X	0	X	X	0	0	X	0	X	0	0	0	0	0
Installation Inspected By State In Past 12-Months	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

0 - Satisfactory; X - Unsatisfactory
1/ Per 1972-73 Laboratory Records, South Dakota Dept. Of Environmental Protection
2/ Fluoridation Started 4/73. No Interruptions In Feed To Date Of Survey, 9/11/73.

SOUTH DAKOTA FLUORIDATION PROGRAM EVALUATION
Figure 1
Fluoridated Water Supply Systems Selected for Study



1 - Belle Fouche
2 - Bowdle
3 - Box Elder
4 - Britton
5 - Canistota
6 - Custer
7 - Mobridge
8 - Parkston
9 - Philip
10 - Pierre
11 - Rapid City
12 - Sioux Falls
13 - Spearfish
14 - Sturgis
15 - Volga
16 - Watertown
17 - Webster
18 - Woonsocket